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ABSTRACT

Literature citations were analyzed to identify periodical literature used in the field of limnology. Journals published in four different countries during 1976 were selected as source journals of cited literature. The results of this analysis were compared to those of a similar study conducted in 1968 using conference proceedings as source journals for citations, to determine (1) if differences in citations exist based upon the choice of citing journals and (2) if changes have occurred in the literature during the intervening time period. The report concludes that most of the same titles appear in both studies, that a large and diverse body of literature is used by limnologists in support of their research, and that the literature needs of limnologists change over time. (Author/DC)

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CHANGING PATTERNS OF LIMNOLOGY LITERATURE, 1966-1976

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ABSTRACT

Analysis of citations has been used as a method to identify periodical literature of various scientific disciplines. The method was employed previously to define literature in the field of limnology using conference proceedings as source journals for citations. The present study a decade later used a different sample of citing journals to determine the nature of cited literature in the field. Many of the same titles of most cited journals appear on the two lists including Limnology and Oceanography the number one journal in the field. Speculation is offered to account for discrepancies in titles on the two recent lists. The introduction of cost factors in citation analysis in future studies could provide new perspective on the question of journal effectiveness.

Analysis of literature citations has been used extensively to identify the literature of various scientific disciplines (Brodman, 1944; Henkle, 1938-39; Brown, 1956; Cawkell, 1978; Garfield, 1972, 1976; Sengupta, 1973, 1974a, 1974b). The technique has been of especial interest in identifying primary literature of disciplines whose boundries are broad and indistinct such as ecology (Anderson, 1966) and agriculture (Garfield, 1975). As suggested by Cawkell (1978) citation analysis can be used to discover not only those titles which provide primary coverage of a discipline, but also those secondary titles which provide sufficient information to justify their inclusion in a library subscription list. I have undertaken a citation analysis in order to identify the literature of limnology, another discipline whose boundaries are not well-defined.

The method of this study, following the techniques of its predecessors, was to identify the periodical literature that limnologists themselves have cited in support of their own published research, the assumption being that this cited literature is a measure of the primary literature of limnology.* Gorham (1968) reports a similar investigation in which citations were identified in two volumes of Proceedings of the International Association of Pure and Applied Limnology. (Verh. int. Verein. theor. agnew. Limnol. 1964, 1966). The earlier of the two volumes presented papers from a meeting in Warsaw, the latter one in the United States.

My study, which was done a decade after Gorham's, provides an oppo. tunity to see what differences if any there may be in the citation literature of limnology as is reflected by a different choice of citing journals and secondarily to observe changes that may have occurred in the literature during the interviewing time. Journals published

*I would like to acknowledge the assistance of Ms. Mary Coleman in the collection of citation data from the source journals used in this study and Dr. Peggy Smith for her helpful criticism of the ideas in the paper.

in four different countries during 1976 were selected as source journals of cited literature in order to provde wide geographical coverage. Each of the four journals is explicitly devoted to the publication of critically reviewed primary research articles relating to pure and/or applied biology of freshwater lakes and streams. With the exception of Freshwater Biology, which commenced publication in 1971, all have been in continuous publication for two decades or more and have achieved reputations for quality within the field. The four citing journals together with their countries of origin and volume numbers analyzed are Archiv für Hydrobiologie (West Germany.) vols. 77, 78; Freshwater Biology (United Kingdom), vol 6; Hydrobiologia (The Netherlands), vols. 48, 49, 50, 51; and Limnology and Oceanology (United States), vol. 21. This group of eight volumes from four journals all published in 1976, provides broad coverage of the cited literature while producing a sample of citations of manageable size for organization and analysis. For the purpose of this study, "Serials are defined as publications which are issued in parts of indeterminate periods at intervals usually of not over one year" (Brown, 1956).

These eight volumes include 363 articles which produce 5783 citations from 912 journals whose titles can be identified from their abbreviations using either World List of Scientific Periodicals (WLSP) of BIOSIS. There are an additional 243 citations in 181 journals whose titles could not be recognized from their abbreviations. Using two source journals mentioned above Gorham identified 309 articles which produce 2568 citations in 703 identified periodicals. (Table #1).

It is not possible to make comparisons between the two studies on the basis of exactly the same number of journals because more than one journal among those being cited may have received the same number of citations. For example, Fresh. Biol. and Verh. int. Verein. theor. agnew. Limnology share the same position in the ranking order since each title received 110 citations hence are tied for eighth and ninth position on the

list. (Table #3). Duplication of citation numbers occurs several places on the list. It is necessary therefore to calculate percentages of the total number of citations on the basis of a position above or below any position that is shared by two or more titles on the list. Where exact comparisons are not possible, sufficiently close positions can be used from the two lists to provide insights into the relative number of journals that are important to the field of limnology. Ten titles thus provided 25% of the citations in 1966; the same number of titles included 33.4% a decade later. Nineteen titles provided 33.3% in 1966 and 45.5 in 1976. In 1966, 52 titles included 505 while 51 titles provided 61.8% in 1976. (Table #2). At each level a similar number of titles produced a larger number of citations in the later survey than was found in the two citing journals in 1966. While it is still true as Gorham asserts that a relatively large number of journals is necessary to support limnology research, that number may be smaller than had earlier been concluded.

Besides the number of journal titles which carry limnology literature, it is perhaps of greater interest to note what those titles are and how those titles compare with ones that were being cited a decade earlier (Table #3). A comparison reveals that most of the same titles appear among the most cited in both lists. Certain exceptions may be noteworthy. For example, Journal of Ecology and Journal of Animal Ecology are among the top ten most cited titles in my study but are 29th and 36th respectively according to the Gorham study. Another example is that of Marine Biology (Berlin) which is sixth in 1976 and does not appear on the earlier list at all. Freshwater Biiology, which has quickly become much cited limnology journal, and is in eighth place in 1976, had not begun publication a decade earlier. Other striking differences in ranking are Reports. Institute of Freshwater Research and Sewage and Industrial Wastes, 24th in 1967 and was 215th a decade later. Of the first 43 titles of the later list against which comparisons can be made, 21 are new, that is, nearly half are titles which if cited at all were cited too infrequently to be included on Gorham's list. It is difficult to know whether the

differences in the two are the consequence of changes in citing patterns that have occurred during the interval between the two studies or perhaps is largely the consequence of the use of different citing journals for compiling the samples. No doubt both factors account to some extent for the differences. Neither is an exact comparison between the two lists on a title by title basis entirely possible because of the incompleteness of abbreviated titles in the Gorham list. The three titles Gesundh Ingr; Limnologica, and Z. Fischerei, so far as I can determine do not appear in WLSP or in BIOSIS at least in a form identifiable from these abbreviations. At the same time, it is not clear which of several journal titles Gorham intends by the abbreviation Compt Rendu. In neither BIOSIS or in WLSP is Compt Rendu used as an abbreviation, although BIOSIS includes over twenty titles which begin as Comptes Rendu.

Another problem which arose in the study is that of knowing from an abbreviation of a citation, such as Dokl. Akad. Adad, Nauk. SSR and Roczniki Nauk Rolniczych, if reference is intended to be made to one or to all of the several series which make up the title in question. The former of these two examples includes at least 13 sections according to WLSP, not all of which would be of equal value to the limnologist. A clearer understanding of citations would be gained if authors included the series designation in a citation in those titles where the information applies.

This study brings added support to conclusions reached by Gorham that a large and diverse body of literature is used by limnologists in support of their research. Literature that reports and supports limnology research is not confined to explicity limnological journals. It also should make clear that literture needs of limnologists change. What may have been adequate and relevant at one time, may no longer be so within as short a time as a single decade. A journal collection, therefore, is in need of constant analysis and evaluation and must be subject to change if it is to remain useful and effective in meeting the literature needs of its constituency. Citation analyses may provide a technique for securing information which may be used for making those changes.

Certain interesting questions arise regarding unit cost per cited article based on such considerations as frequency of publication, subscription cost, and size of the journal per volume or per year. For example a journal published monthly and including twenty articles per issue would provide more opportunities to be cited than one published quarterly with a similar number of articles per issue. On a cost basis, the two journals may be equally effective if the subscription cost of the more frequently published journal were four times greater than the latter and the citation rate of each was proportional. In both cases, the cost per article to the user should be about the same. These kinds of questions have been raised recently in connection with literature analysis of other scientific disciplines (Line, 1975; Line and Sandison, 1975). A study of limnology citation literature which takes these cost factors into account could provide interesting additional information on which to make evaluations of limnology periodical literature as well as supply an additional parameter on which journal ranking could be based. It could prove to be especially useful in deciding the question of providing library subscriptions to those journals which are secondary in the rankings according to citation analysis alone.

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Table 1. Analysis of Source Journals 1966 and 1976.

Author Date of Study	No. journals Analyzed	No. Articles with References	No. Citations	No. Identifiable Periodicals
Gorham, 1966	2	266	2,568	703
Milby, 1976	4 in 8 vols.	363	5,783	912

Table 2. No. of Journals Which Provide Various Percentages of Limnology Literature Citations.

No. of journals	% of total identifiable citations (1966)	% of total identifiable citations (1976)
10	25.0	33.4
19	33.3	45.5
51	-	61.8
52	50.0	-
108	-	72.9
200	75.0	-
224	-	83.2
430	90.0	-

Table 3. Most-Cited Journals in Limnology (1976)

Rank	Gorham Rank	Title (BIOSIS)*	Number of Citations: Arch. Hydrobiol.	Freshwater biol.	Hydro-Biologia	Limon. Oceanogr.	Total Citations
1.	(4)	Limnol. Oceanogr.	57	96	144	355	652
2.	(2)	Arch. Hydrobiol.	113	43	38	15	209
3.	(7)	Hydrobiologia	36	63	92	10	201
4.	(5)	Ecology	16	40	57	42	155
5.	(8)	J. Fish. Res. Board. Can.	15	32	42	52	141
6.	(0)	Mar. Biol. (Berl.)	4	14	50	61	129
7.	(29)	J. Ecol.	19	52	46	11	128
8.	(0)	Freshwater Biol.	15	72	17	6	110
9.	(1)	Verh. int. Verein. theor. angew. Limnol.**	36	32	41	1	110
10.	(36)	J. Anim. Ecol.	16	57	21	4	98
11.	(3)	Int. Revue. ges. Hydrobiol. Hydrogr.**	26	26	26	15	93

12.	(13)	Science	3	7	21	58	89
13.	(28)	J. Mar. Biol. Assoc. UK	7	23	18	37	85
14.	(23)	Nature. (Lond.)	10	28	21	23	82
15.	(0)	Deep Sea Res.	6	3	6	62	77
16.	(0)	J. Phycol	1	2	18	52	73
17.	(16)	Biol. Bull. (Woods Hole)	5	2	34	25	66
18.	(39)	Oikos.	24	25	8	7	64
19.	(0)	Mitt. int. Ver. theor. angew. Limnol.	1	13	12	35	61
20.	(0)	Ecol. Monogr.	5	12	22	18	57
21.	(38)	J. Mar. Res.	5	5	4	41	55
22.	(0)	Comp. Biochem. Physiol.	6	3	27	4	40
23.	(0)	J. Cons. Int. Explor. Mer.	2	6	12	20	40
24.	(0)	Geochim. Cosmochim. Aeta.	2	10	—	27	39
25.	(0)	Trans. Am. microsc. Soc.	6	7	23	3	39
26.	(0)	Arch. Mikrobiol.	6	9	4	18	37
27.	(10)	Schweiz Z. Hydrol.	24	7	3	2	36
28.	(0)	Proc. R. Soc. Lond. B. Biol. Sci	6	13	8	9	36
29.	(29)	Mem. Ist. ital. Idrobiol. Dott Marco deMarchi	11	10	8	6	35
30.	(32)	Can. J. Zool.	3	14	14	4	35

31.	(0)	Proc. R. Soc. Edinl. Sect. B (Nat. Environ.)	40	32	1	1	34
32.	(0)	J. Bacteriol.	8	3	5	15	31
33.	(14)	Trans. Am. Fish. Soc.	5	6	14	4	29
34.	(0)	Proc. Zool. Soc. Lond.	3	10	11	3	27
35.	(0)	Trans. Wis. Acad. Sci. Arts. Lett.	4	9	11	3	27
36.	(22)	J. exp. Biol.	5	11	9	--	25
37.	(26)	Bull. Fish. Res. Board Can***	4	2	7	11	24
38.	(0)	New Phytol.	6	11	6	1	24
39.	(0)	Physiol. Zool.	1	3	19	1	24
40.	(0)	Biol. Rev. Camb. Philos Soc	1	11	6	5	23
41.	(0)	Can. J. Microbiol.	—	2	9	12	23
42.	(0)	J. Water Pollut. Control Fed.	2	--	12	9	23
43.	(0)	Physiologia Pl.	5	9	4	5	23
44.	(0)	Plant Physiol (Bethesda)	4	8	2	9	23
45.	(0)	Pol. Arch. Hydrobiol.	5	7	6	5	23
46.		Environ. Sci. Technol.	6	4	3	8	21
47.		Oecologia (Berl)	2	8	7	4	21
48.		J. Exp. Mar. Biol. Ecol.	1	3	3	13	20
49.		J. Geophys. Res.	--	--	--	20	20
50.		Am. Midl. Nat.	3	4	9	3	19

51.	J. gen. Microbiol.	2	3	7	7	19
52.	Am. Nat.	2	1	4	11	18
53.	Bioscience	3	3	4	8	18
54.	Ekol. pol. Ser. A.	3	8	5	2	18
55.	Scient. Publs. Freshw. biol. Asso.**	--	14	4	--	18
56.	Water Res.	4	3	3	7	17
57.	Can J. Bot.	5	1	6	4	16
58.	Biochim. Biophys. Act.	2	2	3	8	15
59.	Earth Plan**	3	1	--	11	15
60.	J. biol. Chem.	—	2	4	9	15
61.	Am. J. Bot.	1	2	5	6	14
62.	Br.. Phycol. J.	3	4	6	1	14
63.	J. Sediment Petrol	2	1	--	11	14
64.	Proc. Natl. Acad. Sci. USA	2	3	1	8	14
65.	Zool. Anz.	8	1	4	1	14
66.	Anal. Chem.	--	1	3	9	13
67.	Ann. Entomol. Soc. Am.	3	4	4	2	13
68.	Am. J. Sci.	4	--	1	7	12
69.	Analytica chim. Acta.**	1	4	3	4	12
70.	Bot. Mag., Tokyo	2	6	3	1	12

71.	Bot. Rev.	3	2	7	--	12
72.	Gas. U. Wass Fach**	10	---	1	1	12
73.	Helgol wiss. Meersunters	3	1	2	6	12
74.	Soil Sci.	7	--	3	2	12
75.	Z. Vgl. Physiol.	9	--	3	--	12
76.	Ann. Bot.	4	1	3	3	11
77.	Ann. N. Y. Acad. Sci.	1	--	7	3	11
78.	Bull. Jpn. Soc. Sci. Fish	--	-1	7	3	11
79.	J. exp. Bot.	3	2	2	4	11
80.	Kiel Meeresforsch	6	1	3	1	11
81.	Symb. bot. ups.	--	2	7	2	11
82.	Freshwater Biol. Assoc. Sci. Publ.	5	1	1	3	10
83.	J. phys. Chem., Ithaca**	--	4	--	6	10
84.	Trans. R. Entomol Soc. Lond	3	5	2	--	10
85.	Acta hydrobiol.,	7	2	--	--	9
86.	Annu. Rev. Entomol	3	3	2	1	9
87.	Appl. Microbiol.	1	--	5	3	9
88.	Biochem. J.	--	--	2	7	9
89.	Doki. Akad. Nauk. SSSR	1	3	3	2	9
90.	J. Appl. Ecol.	3	5	--	1	9

91.	J. Protozool.	1	—	2	6	9
92.	Malacologia	1	1	6	1	9
93.	Naturwissenschaften	4	—	3	2	9
94.	Oceanogr. Mar. Biol. Annu. Rev.	—	—	2	7	9
95.	Publs. Ont. Fis. Res. Lab***	—	1	8	-	9
96.	Syst. Zool.	1	3	1	4	9
97.	Adv. Mar. Biol.	—	1	—	7	8
98.	Annls. Ist. Oceanog., Monaco**	—	1	2	5	8
99.	Can. Entomol	3	3	1	1	8
100.	"Discovery" Rep.	0	0	0	8	8
101.	Investigacion**	2	—	2	4	8
102.	J. exp. Zool.	3	—	5	—	8
103.	J. Zool., Lond.	3	4	1	—	8
104.	Mikrobiologiya	—	5	1	2	8
105.	Ohio j. Sci.	3	1	4	—	8
106.	Planta. (Berl)	2	3	1	2	8
107.	Proc. Indian Sci. Congr.**	—	—	8	—	8
108.	Vidensk. Medd dan naturhist Foren.	4	2	2	—	8
	Total	22				4,217

18	Journals cited 7-times only	126
28	Journals cited 6-times only	168
27	Journals cited 5-times only	135
42	Journals cited 4-times only	168
71	Journals cited 3-times only	213
129	Journals cited 2-times only	258
489	Journals cited 1-time only	489
	Total number identified citations	5,783
	Total number unidentified citations	243
	Grand Total Number of Citations	6,026

* Journal title abbreviations according to BIOSIS unless otherwise indicated.

** WLSP abbrev.

*** No longer published